Claims

1. A dual axis bioreactor for growing cell or tissue cultures comprising:

a chamber for containing a cell or tissue culture and a culture medium for growing cell or tissue cultures;

a drive mechanism for rotating the chamber at a first speed about a first axis and at a second speed about a second axis, the second axis being substantially normal relative to the first axis, wherein the magnitude of the first speed and the second speed are independently variable of each other to thereby grow a cell or tissue culture within the chamber.

2. A dual axis bioreactor as claimed in claim 1, further comprising:

a first rotatable member rotatable about the first axis and coupled to the chamber for rotating the chamber about the first axis; and

a second rotatable member rotatable about the second axis, the second rotatable member coupled to the chamber for rotating the chamber about the second axis.

3. A dual axis bioreactor as claimed in claim 1, further comprising at least one fluid connector comprising:

a stationary casing;

a rotatable shaft mounted to the stationary casing, the shaft rotatable about a shaft axis in axial alignment with, or axially offset from, either the first or second axes; and

at least one fluidly sealed passage defined between the juncture of the stationary casing and the rotatable shaft and extending through the casing and the rotatable shaft, wherein the fluidly sealed passage allows passage of fluid from or to the chamber, or both, as the shaft rotates about the shaft axis.

4. A dual axis bioreactor as claimed in claim 1, further comprising a heater element that is thermally coupled to the chamber for heating material within the chamber.

5. A dual axis bioreactor as claimed in claim 4, wherein the heater element is disposed adjacent to an outer surface of the chamber.

6. A dual axis bioreactor as claimed in claim 1, further comprising one or more detector elements for detecting a variable of the material within the chamber.

7. A dual axis bioreactor as claimed in claim 6, wherein the variable of the material within the chamber is selected from the group consisting of: pH; temperature; dissolved oxygen content; and one or more combinations thereof.

8. A dual axis bioreactor as claimed in claim 1, further comprising a force detector for detecting the force applied the chamber as it rotates about the first axis or the second axis, or both.

9. A dual axis bioreactor as claimed in claim 3, wherein one fluidly sealed passage is provided in the fluid connector for passage of feed material to the chamber, and another fluidly sealed passage is provided in the fluid connector for passage of product material from the chamber.

10. A dual axis bioreactor as claimed in claim 2, further comprising an adjustment mechanism provided on the first rotatable member or the second rotatable member for respectively adjusting the position of the chamber relative to the second axis or the first axis.

11. A dual axis bioreactor as claimed in claim 2, wherein the drive mechanism includes at least one motor that is coupled to

the first or second rotatable members, or both, by at least one drive shaft.

12. A dual axis bioreactor as claimed in claim 2, wherein the drive mechanism includes:

a first motor coupled to the first rotatable member by an outer drive shaft having a hollow passage extending through its axis; and

a second motor coupled to the second rotatable member by an inner drive shaft disposed at least partly within the hollow passage of the outer drive shaft.

13. A dual axis bioreactor as claimed in claim 2, wherein the drive mechanism includes:

a first motor coupled to the first rotatable member by a first drive shaft; and

a second motor disposed within, or on, the second rotatable member and coupled to the second rotatable member by a second drive shaft.

14. A dual axis bioreactor as claimed in claim 11, wherein the first and second motors are servo motors.

15. A dual axis bioreactor as claimed in claim 11, wherein the drive shaft is coupled to the motor by a gear train for controlling the speed of rotation of the shaft.

16. A dual axis bioreactor as claimed in claim 1, wherein the chamber further comprises a feed conduit for passage of feed media into the chamber and an outlet conduit for passage of product material from the chamber.

17. A method for growing cell or tissue cultures in vitro comprising the steps of:

(a) providing a chamber having a cell or tissue culture and a culture medium;

(b) rotating the chamber about a first axis at a first speed; and

(c) rotating the chamber about a second axis at a second speed, the second axis being substantially normal to the first axis and wherein the magnitude of the first speed and the second speed are independently variable of each other to thereby grow a cell or tissue culture.

18. A system for growing cell or tissue cultures in vitro comprising:

a bioreactor comprising

a chamber for containing a cell or tissue culture and a culture medium for growing cell or tissue cultures;

a drive mechanism for rotating the chamber at a first speed about a first axis and at a second speed about a second axis, the second axis being substantially normal relative to the first axis; and

a controller for controlling the operation of the drive mechanism, wherein the magnitude of the first speed and the second speed are independently variable of each other to thereby grow a cell or tissue culture within the chamber.

19. A continuous flow dual axis bioreactor for growing cell or tissue cultures comprising:

a chamber for containing a cell or tissue culture and a culture medium;

a first rotatable member rotatable about a first axis, the first rotatable member coupled to the chamber for rotating the chamber about the first axis in use;

a second rotatable member rotatable about a second axis, the second axis being substantially normal relative to the first axis, the second rotatable member coupled to the chamber for rotating the chamber about the second axis;

a drive mechanism for rotating the first rotatable member at a first speed about the first axis and the second rotatable member at a second speed about the second axis, wherein the magnitude of the first speed and the second speed are

independently variable of each other to thereby grow a cell or tissue culture within the chamber; and

a fluid connector for providing fluid material passage to and from the chamber.

20. A continuous flow dual axis bioreactor as claimed in claim 19, wherein the fluid connector comprises:

a stationary casing;

a rotatable shaft mounted to the stationary casing, the shaft rotatable about a shaft axis in axial alignment with, or axially offset from, either the first or second axes; and

at least two fluidly sealed passages defined between the juncture of the casing and the rotatable shaft and extending through the casing and the rotatable shaft, wherein both fluidly sealed passages are configured such that they are in fluid communication with the chamber as it rotates about the first and second axes;

wherein in use, one of the fluidly sealed passages provides an inlet passage for fluid material to the chamber and the other fluidly sealed passage provides an outlet passage for removal of fluid material from the chamber.

21. A cell or tissue culture when grown in vitro by the method of claim 17.

22. A three-dimensional cell or tissue culture when grown in vitro by the method of claim 17.

23. A dual axis bioreactor as claimed in claim 1, wherein the chamber further comprises a mount for retaining a scaffold for growing three-dimensional tissue culture constructs.